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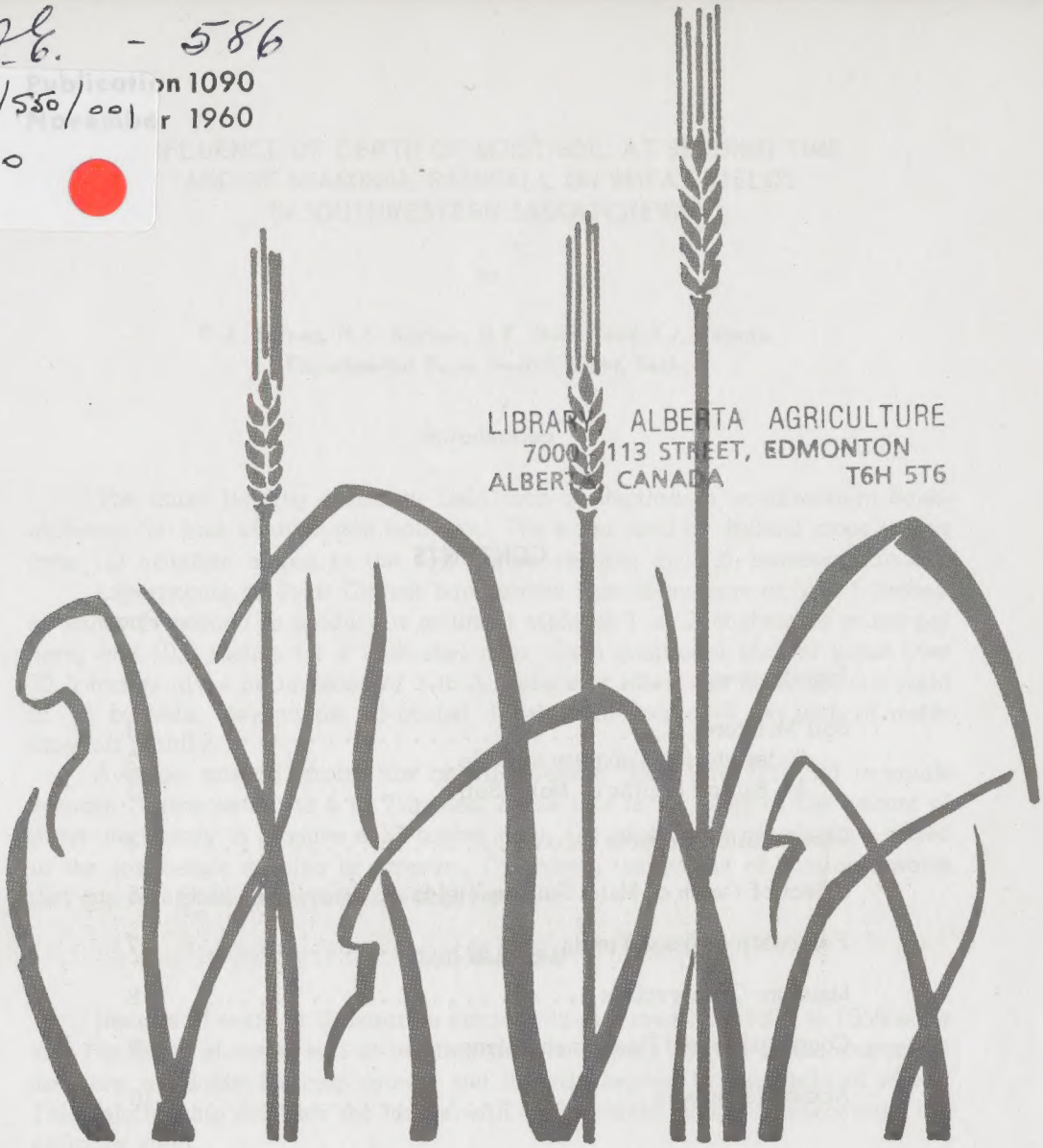

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INFLUENCE OF DEPTH OF MOIST SOIL AT SEEDING TIME AND OF SEASONAL RAINFALL ON WHEAT YIELDS IN SOUTHWESTERN SASKATCHEWAN

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CONTENTS

	Page
Introduction	3
Soil Moisture	3
Water-storing Capacity of Soils	3
Measuring Depths of Moist Soil	3
Precipitation Records	4
Effect of Depth of Moist Soil on Yields	5
Forecasting Wheat Yields	7
Moisture Conservation	8
Conclusions and Recommendations	9
Acknowledgments	10

INFLUENCE OF DEPTH OF MOIST SOIL AT SEEDING TIME AND OF SEASONAL RAINFALL ON WHEAT YIELDS IN SOUTHWESTERN SASKATCHEWAN

by

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Experimental Farm, Swift Current, Sask.

Introduction

The chief limiting factor in field crop production in southwestern Saskatchewan is lack of available moisture. The water used by dryland crops comes from (1) moisture stored in the soil before seeding and (2) seasonal rainfall.

Experiments at Swift Current have shown that an average of 5 to 6 inches of water is needed to produce a minimum yield of 1 or 2 bushels of wheat per acre, and 10.5 inches for a 15-bushel crop. Each additional inch of water over 10.5 inches gives an increase of 3 to 5 bushels of wheat per acre, up to a yield of 30 bushels. Beyond the 30-bushel level, yield increases per inch of water taper off rapidly.

Average rainfall during the growing season (May 1 to July 31) in southwestern Saskatchewan is 5 to 7 inches. Since this is far short of the amount of water necessary to produce a 15-bushel crop, the importance of moisture stored in the soil before seeding is apparent. Of course, the amount of available water that can be stored varies with the soil type.

Soil Moisture

Results of tests at illustration stations in this area from 1938 to 1959 show that the depth of moist soil at seeding time is closely related to the amount of moisture available for crop growth and directly related to the yield of wheat. This relationship provides the farmer with a convenient basis for forecasting his probable yield.

Water-storing Capacity of Soils

The quantities of water that soils can hold vary with the soil textures. Sandy soils will hold about 4 inches of available water within the depth of root penetration (about 4 feet), loams and clay loams 6 to 7 inches, and clays about 8 inches. Sandy soils lose moisture by percolation, particularly in years when precipitation is above normal; clay soils seldom lose moisture in this way.

Measuring Depths of Moist Soil

During the 22 years of this study, the depth of moist soil was measured by taking several samples with an auger (Figure 1) at representative sites in a field. The soil was considered moist if it would stick together when pressed into a ball

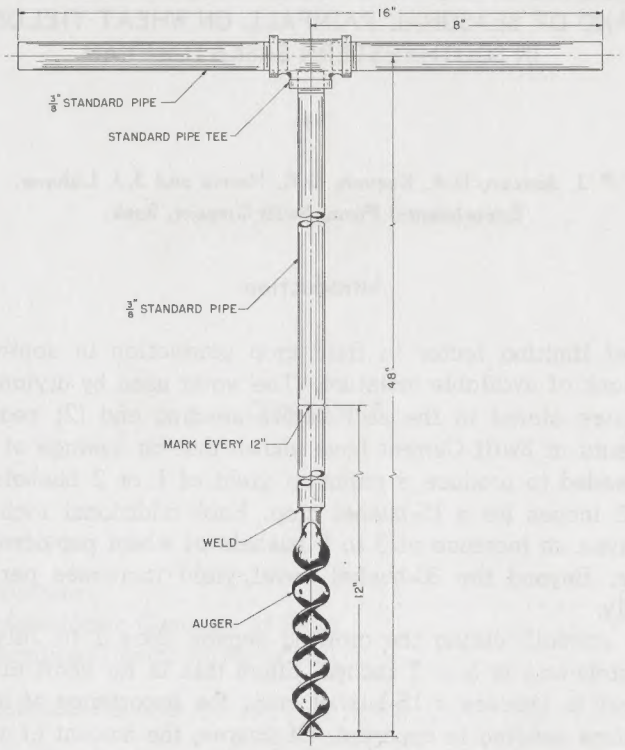

Figure 1. Plan for construction of a soil auger with a 1- or 1¼-inch wood bit and 3/8-inch standard pipe and T-union.

(Figure 2). The dividing line between moist and dry soils was usually distinct in stubble land but in fallow it was sometimes difficult to determine. The fallow fields were frequently only 'partially moist' at the greater depths.

Precipitation Records

Precipitation has been recorded at each illustration station since it was established. However, the records are more complete for seasonal rainfall than for annual precipitation, because in early years rainfall was recorded only during the summer months.

Although there are too few recording stations in the region to establish a definite pattern of precipitation, there is a wide variation in the average precipitation recorded (Table 1). For example, Fox Valley with an average annual precipitation of 10.3 inches and an average seasonal rainfall of 4.48 inches, had the lowest precipitation. In 23 of the 32 years the seasonal rainfall there was less than 5 inches. The station at Carmichael, located on the Cypress Bench, had the highest average annual precipitation of 15.98 inches and an average seasonal

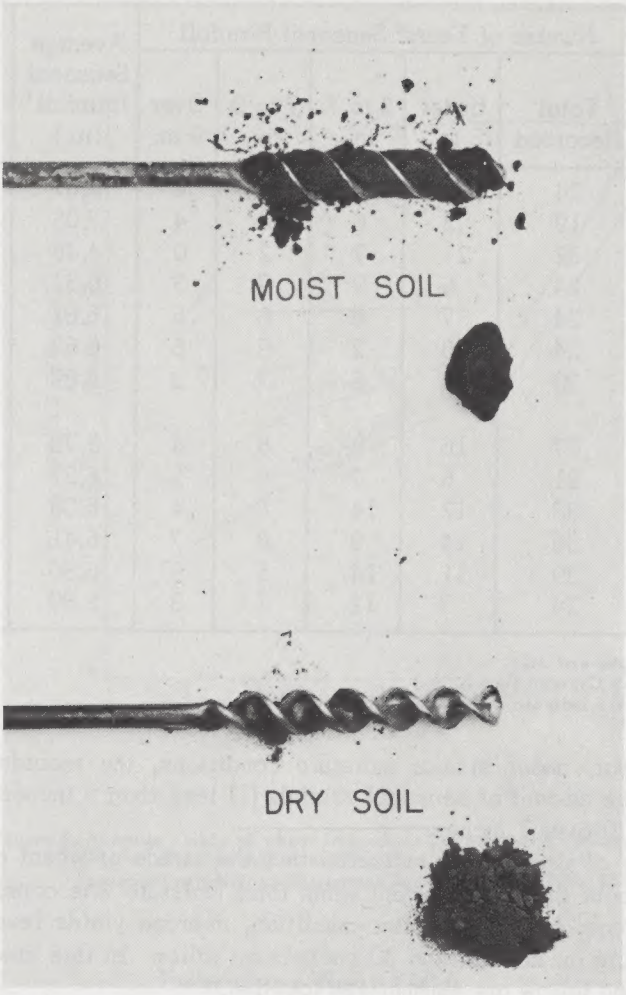

Figure 2. Moist soil clings to auger and sticks together when pressed into a ball. Dry soil does not cling to auger or stick together.

rainfall of 7.05 inches. In only 3 out of 19 years was the seasonal rainfall there below 5 inches.

Effect of Depth of Moist Soil on Yields

In the measurements referred to above, depths of moist soil at seeding time and yields of wheat were recorded for 402 individual fields: 258 on fallow and 144 on stubble. To study the effect of depth of moist soil at seeding time on

Table 1.– Average Seasonal Rainfall and Annual Precipitation at 13 Illustration Stations in Southwestern Saskatchewan

Station	Number of Years' Seasonal Rainfall					Average Seasonal Rainfall[1] (in.)	Average Annual Precipitation (in.)
	Total Recorded	Under 5 in.	5 to 7 in.	7 to 9 in.	Over 9 in.		
Bracken	24	12	5	3	4	5.87	12.30 (23)[3]
Carmichael[2]	19	3	6	6	4	7.05	15.98 (19)
Fox Valley	32	23	7	2	0	4.48	10.31 (23)
Gravelbourg	24	5	9	7	3	6.32	13.31 (23)
Kincaid	24	7	6	6	5	6.61	13.57 (23)
Limerick	24	8	2	9	5	6.67	14.37 (23)
Mortlach	20	4	6	7	3	6.89	14.35 (19)
Riverhurst-Gilroy	37	16	9	8	4	5.78	11.85 (22)
Shackleton	21	6	7	6	2	6.37	12.96 (19)
Shaunavon	38	12	14	8	4	6.08	13.00 (21)
Swift Current	38	14	9	8	7	6.41	13.91 (37)
Tugaske	39	11	14	5	9	6.56	15.27 (23)
Valjean	24	7	12	2	3	5.89	13.40 (21)

[1]Total for May, June and July.
[2]Station located on Cypress Bench.
[3]Figures in brackets indicate number of years' records.

yields of wheat, under similar moisture conditions, the records were grouped according to the amount of seasonal rainfall (1) less than 5 inches, (2) from 5 to 7 inches and (3) over 7 inches.

Analysis of the records indicated that the yields of wheat on stubble and fallow were about the same, except when total moisture was considerably below or above average. Under the latter condition, average yields levelled off at 22 bushels per acre on stubble and 30 bushels on fallow. In this study, the results from stubble and fallow are summarized together.

The results show how the depth of moist soil at seeding time and the seasonal rainfall affect yields (Figure 3). For example, when depth of moist soil was 20 inches or less and seasonal rainfall under 5 inches, the average yield of wheat was between 6 and 7 bushels per acre; when rainfall was the same and depth of moist soil increased to 46 inches or more, the average yield increased to about 24 bushels per acre. Similarly, with 5 to 7 inches of rainfall, the average yield of wheat increased from 10 bushels per acre where there was a depth of 20 inches of moist soil, to 27 bushels per acre when the depth of moist soil measured 46 inches or more.

Records of this study indicate that seeding grain on stubble land is a sound practice in southwestern Saskatchewan in years when moisture reserves are good, but not when they are low. Total production can be increased, and many

crop failures avoided, by measuring the depth of moist soil at seeding time and deciding accordingly the amount of land to be seeded or fallowed.

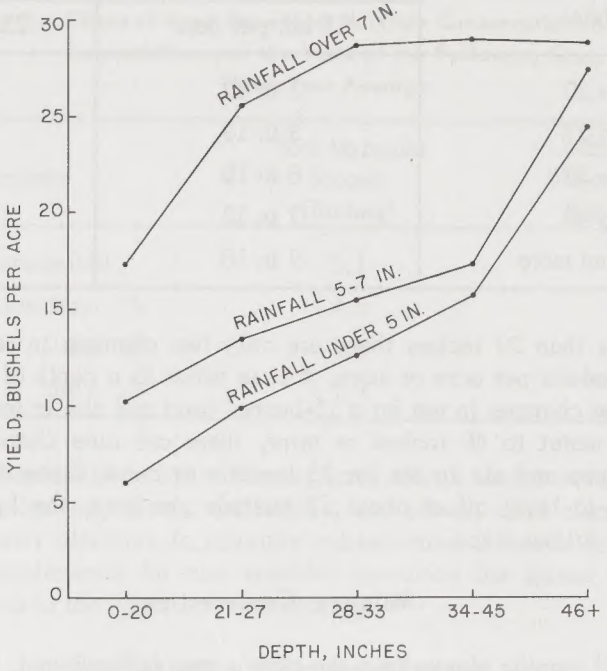

Figure 3. Average yields of wheat in bushels per acre with various depths of moist soil at seeding time, and amounts of seasonal rainfall, southwestern Saskatchewan, 1939-1959.

Forecasting Wheat Yields

Seasonal rainfall, which may vary from 2 to 12 inches in southwestern Saskatchewan, definitely influences crop yields. Since there is no way at the start of a season to predict either the amount or distribution of the rainfall, it is impossible to predict exact yields. However the *probable* yield of wheat can be calculated (Figure 3) from the average seasonal rainfall (Table 1) and the depth of moist soil at seeding time. For example, if the depth of moist soil at seeding time is between 21 and 27 inches and the average seasonal rainfall less than 5 inches, the probable yield is about 10 bushels per acre; with a seasonal rainfall of 5 to 7 inches, 13 to 14 bushels; and with over 7 inches of rain, 25 bushels.

The chances of obtaining a yield of 15 or 25 bushels per acre (Table 2) have been calculated on the basis of the above data. If the soil is moist to a

Table 2.– Chances of a Wheat Yield as Large as or Larger than 15 or 25 Bushels Per Acre with Various Depths of Moist Soil, Southwestern Saskatchewan, 1938-1959

Depth of Moist Soil (inches)	Chances	
	15 bu. per acre	25 bu. per acre
0 to 20	2 in 10	–
20 to 27	3 in 10	1 in 10
27 to 33	6 in 10	2 in 10
33 to 45	7 in 10	3 in 10
46 and more	9 in 10	6 in 10

depth of less than 20 inches there are only two chances in ten that the yield will be 15 bushels per acre or more; if it is moist to a depth of 21 to 27 inches, there are three chances in ten for a 15-bushel yield and one in ten for 25 bushels; and if it is moist to 46 inches or more, there are nine chances in ten for 15 bushels or more and six in ten for 25 bushels or more. Since average yields on stubble tend to level off at about 22 bushels per acre, the larger yield would apply only to fallow crops.

Moisture Conservation

About 21 months elapse from the time a crop is harvested, through a season of summerfallow, to the planting of the succeeding crop. During this period every effort should be made to trap and conserve the moisture that falls.

Studies conducted at a number of illustration stations in southwestern Saskatchewan showed that the average moisture conserved for the first nine months of the fallow period was about 2.2 inches (33 per cent of the total precipitation) and for the last 12 months only 1.8 inches (14 per cent of the precipitation); thus, 4 inches of moisture was conserved during the 21-month period.

Moisture conservation depends on weather and soil conditions. A farmer cannot control the weather, but he *can do* something about soil conditions.

Results from experiments conducted at Swift Current show that more moisture was conserved by leaving the stubble standing, to trap snow during the winter, than if it was worked down or destroyed by fire. Where weeds are a problem, fall blading to destroy the growth and at the same time retain the stubble in an upright position has been beneficial. However, where weeds are not a problem fall cultivation has not noticeably improved moisture conservation.

Weeds are one of the most serious factors causing moisture loss. Early spring growth of weeds can use all of the moisture in the soil. Table 3 shows

clearly that to delay control of weeds seriously depletes moisture reserves and decreases grain yields. Consequently, proper timing of the first cultivation is very important. Subsequent operations should be undertaken at sufficient intervals to keep weeds under control at all times.

Table 3.– Effect of Weed Growth on Moisture Conservation in Summerfallow and the Yield of the Following Crop, Three-Year Average

Treatments	Soil Moisture Stored (inches)	Comparative Wheat Yields (per cent)
Weed growth prevented	5.1	100
First cultivation May 15	4.5	88
" " June 15	3.6	78
" " July 15	1.9	47

Cultural experiments at Swift Current have shown that several implements including blades, one-way discs, cultivators, and plows, used alone or in combination, are equally effective in moisture conservation if weeds are controlled. When choosing implements for any specific operation the farmer should give major consideration to the hazard of soil drifting.

Conclusions and Recommendations

(1) Lack of adequate moisture is the most important limiting factor in crop production in southwestern Saskatchewan.
(2) Observations made during a 22-year study show that the greater the depth of moist soil at seeding time the higher the average yield of wheat.
(3) An estimate of the yield of wheat can be obtained if you know the depth of moist soil at seeding time and the probable seasonal rainfall.
(4) In areas of low precipitation, do not seed stubble land unless the depth of moist soil is at least 18 inches in clay soils, 24 inches in loams, and 30 inches in sandy soils at the time of seeding.
(5) Leave stubble in an upright position to trap snow during the first fall and winter. Where weeds are a problem, fall blading destroys them without disturbing the stubble any more than necessary. Where weeds are not a problem, fall tillage is not advantageous.
(6) Start fallow operations in the spring as soon as weeds show any signs of growth. Select and operate machinery carefully. Destroy weeds completely with each operation and keep them under control throughout the year. Prevent soil drifting by keeping stubble anchored at the surface.

Acknowledgments

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